

Free Space Optical Communications at the NASA Jet Propulsion Laboratory

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Free space laser communication technology has been under development for the past several years at the NASA, Jet Propulsion Laboratory. In comparison to RF communication systems, optical communications offer bandwidth advantages supporting higher data rates (up to several Gbps) and much smaller beam divergence. For spaceborne applications, the smaller transmit aperture can lead to reduced terminal mass and power requirements which translates directly into lower payload launch costs. A further advantage over existing and future microwave technology is the lack of frequency allocation requirements for laser wavelengths. The challenge for laser communications is the stringent pointing requirements imposed by the narrow beamwidth, cloud blockages and atmospheric induced scintillation effects.

The JPL/NASA optical communications requirements are driven firstly by the need for high-data-rate communications from low-Earth orbiters to GEO to ground, and secondly by lower data rate (100 kbps-10 Mbps) communications from deep space probes. Although there are areas of overlap between these communications scenarios, the arenas can be differentiated by the requirements on the laser source and data detector. The much larger distances for deep space communications require high photon efficiency which is attained by utilizing high peak power lasers. Diode pumped solid state lasers using a pulse position modulation (PPM) format with data rates less than Mbps are well suited to such applications. Near earth applications on the other hand do not require as high photon efficiencies and can provide data rates up to several Gbps with a few Watts average power. Direct diode and fiber based master-oscillator power-amplifier (MOPA) type devices such as are used in terrestrial communication networks are potential candidates for these LEO or GEO based systems.

An overview of different laser communications systems for various NASA missions will be presented with a focus on high data rate lasers that satisfy near-Earth mission requirements. Performance of laboratory prototypes of fiber and diode based MOPAs will be reported in this presentation.